

What is claimed is:

- 1 1. A device comprising:
2 a composite material comprising aligned nanowires at least partially
3 coated by a magnetic material, wherein the nanowires are electrically
4 connected by at least one of contact among the nanowires and a conductive
5 material present in the composite material, wherein at least a portion of the
6 nanotubes protrude from a surface of the composite material by an average
7 protrusion of at least twice the average diameter of the nanowires, and
8 wherein the nanowires have an average length of about 0.1 μm to about
9 10,000 μm .
- 1 2. The device of claim 1, wherein the device is an electron field
2 emission device.
- 1 3. The device of claim 1, wherein the protruding nanotubes
2 comprise broken ends.
- 1 4. The device of claim 1, wherein the magnetic material comprises
2 less than about 0.95 vol.% of the coated nanowires.
- 1 5. The device of claim 4, wherein the magnetic material comprises
2 less than about 0.75 vol.% of the coated nanowires.
- 1 6. The device of claim 1, wherein the average protrusion height is
2 at least 20 nm.
- 1 7. The device of claim 6, wherein average protrusion height is at
2 least 100 nm.

1 8. The device of claim 1, wherein the composite material comprises
2 at least 1 vol.% nanowires to a depth of at least 2 μm from the surface from
3 which the nanowires protrude.

1 9. The device of claim 1, wherein the variation in average
2 protrusion height is less than 40%.

1 10. The device of claim 1, wherein the composite material comprises
2 the conductive material.

1 11. The device of claim 1, wherein the composite material is
2 disposed on a substrate as an arrayed emitter structure.

1 12. The device of claim 1, wherein the composite material is part of
2 an emitter structure, and wherein the device further comprises an apertured
3 grid located over at least a portion of the composite material, the grid
4 comprising a grid layer and an insulating layer.

1 13. The device of claim 1, wherein the composite material is part of
2 an emitter structure, and wherein the device further comprises an apertured
3 grid located over at least a portion of the emitters, the grid comprising at
4 least a first and a second grid conductor layer, the first grid conductor layer
5 separated from the emitter structure by a first insulating layer, and the first
6 and second grid conductor layers separated by a second insulating layer.

1 14. The device of claim 13, wherein the apertured grid further
2 comprises third and fourth grid conductor layers, the third grid conductor
3 layer separated from the second grid conductor layer by a third insulating
4 layer, and the fourth grid conductor layer separated from the third grid
5 conductor layer by a fourth insulating layer.

1 15. The device of claim 1, wherein the nanowires are selected from
2 carbon, silicon, and germanium.

1 16. The device of claim 15, wherein the nanowires are carbon
2 nanotubes and at least a portion of the magnetic material is present in the
3 interior of the nanotubes.

1 17. The device of claim 1, wherein the coating comprises a structure
2 selected from the group consisting of ferromagnetic, ferrimagnetic, near-
3 superparamagnetic, and superparamagnetic.

1 18. The device of claim 17, wherein the structure is selected from
2 the group comprising near-superparamagnetic and superparamagnetic.

1 19. A process for fabricating a device comprising a field emission
2 structure, comprising the steps of:
3 providing nanowires at least partially coated by a magnetic material,
4 the nanowires having an average length of about 0.1 μm to about 10,000 μm ;
5 mixing the nanowires with a liquid medium;
6 applying a magnetic field to the nanowires, such that the nanowires
7 become aligned;
8 securing the aligned nanowires in a matrix; and
9 exposing a portion of the aligned nanowires to provide protrusion from
10 a surface of the matrix by an average protrusion of at least twice the average
11 diameter of the nanowires.

1 20. The process of claim 19, wherein the magnetic field is a gradient
2 magnetic field.

1 21. The process of claim 19, wherein the liquid medium comprises a
2 precursor capable of being treated to form the matrix.

1 22. The process of claim 19, wherein the liquid medium comprises at
2 least one of a binder and an adhesive.

1 23. The process of claim 19 wherein the matrix comprises a
2 conductive material.

1 24. The process of claim 19, wherein application of the magnetic
2 field induces alignment such that one end of the aligned nanowires
3 substantially contacts a substrate.

1 25. The process of claim 19, wherein the exposing step comprises
2 removing a surface portion of the matrix material.

1 26. The process of claim 19, wherein the exposing step comprises
2 separating the matrix comprising the nanowires from at least one of a
3 removable layer and a particle layer.

1 27. The process of claim 26, wherein the removable layer comprises
2 a gel-like layer.

1 28. The process of claim 19, wherein the exposing step comprises
2 sectioning the matrix comprising the nanowires and removing a surface
3 portion of the matrix material from the resulting body.

1 29. The process of claim 19, wherein the liquid medium comprises a
2 surfactant.

1 30. The process of claim 19, further comprising the step of shear
2 mixing the mixture comprising the nanowires and the liquid medium.

1 31. A process for fabricating a device comprising an arrayed field
2 emission structure, comprising the steps of:

3 providing a substrate comprising an arrayed pattern of conductive
4 metal pads;

5 depositing onto the metal pads a mixture comprising liquid, a
6 conductive material, and nanowires at least partially coated by a magnetic
7 material; and

8 applying a magnetic field to the nanowires, such that the nanowires
9 become aligned; and

10 removing the liquid components of the mixture and consolidating the
11 conductive material to form a matrix around the nanowires, such that a
12 portion of the nanowires protrude from the surface of the matrix.

1 32. The process of claim 31, wherein the average protrusion of the
2 nanowires from the surface of the matrix is 0.1 to 10 μm .

1 33. The process of claim 31, where the average length of the
2 nanowires is 0.1 to 100 μm .

1 34. The process of claim 31, wherein the mixture further comprises
2 a surfactant.

1 35. The process of claim 31, further comprising the step of shear
2 mixing the mixture prior to deposition.

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